Modeling Alert Message Dissemination via Multi-Channel Electronic Communication Systems

Michael Klafft
Fraunhofer FOKUS and FOM University of Applied Sciences
Michael.Klafft@fokus.fraunhofer.de

Agenda

- Motivation and Research Questions
- Previous Research
- Empirical study
- An approach to model alert dissemination
- Conclusions

Motivation and Research Questions

- In Germany: reduced coverage of the siren-based alerting infrastructure after the end of the cold war
- Increasing difficulties to cover the „last mile“ when alerting the population in case of disasters
- Availability of electronic alerting channels (e-mail, SMS, pagers) in addition to sirens

→ Multi channel alerting systems emerge

→ But: how efficient can such systems be?

  → Do people notice alerts?

  → Do they act as instructed?

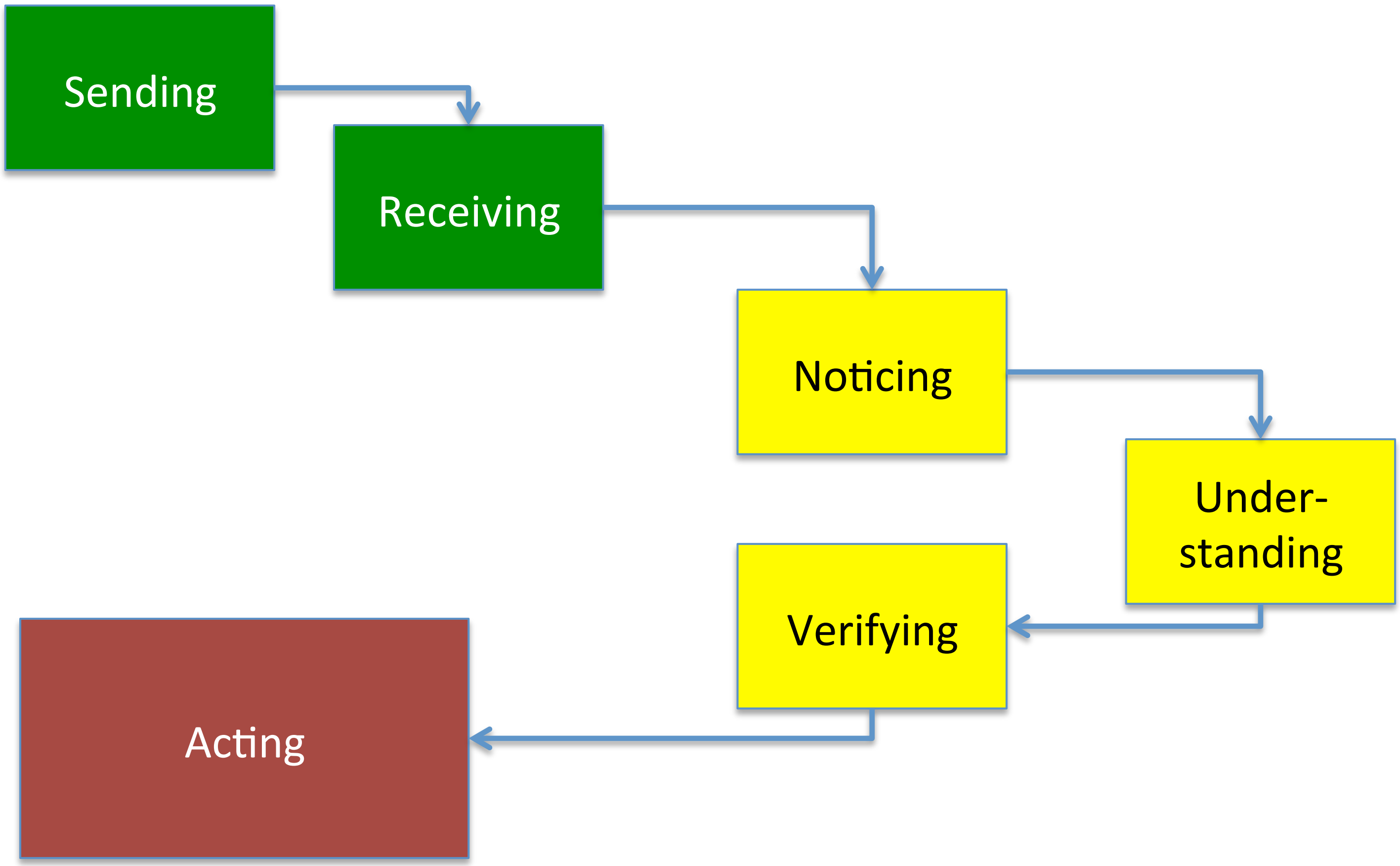
→ How can alert message diffusion be modelled?

Previous research

- Simulation-based approaches
  - USA
  - 1990-2000 (exclude „modern“ communication channels)
- Practical tests with experimental systems (single channel)
  - Netherlands: Cell broadcasting, SMS (e.g. Jagtman 2010)
  - Australia: automated fixed-line telephone calls (2006)
- Gaps:
  - No multi-channel real world system for the general population analyzed
  - Existing studies do not cover Germany

Previous research

- Alert process chain (modified from Jagtman 2010, United Nations 2006)



Setting of the empirical studies

- Studies were conducted using the „KATWARN" alerting system
  - Alerting via SMS, E-Mail, pagers
  - Subscription based opt-in system (data protection laws!)
  - Role-based alerting (general public, first responders, etc.)
  - Composition of alert messages from text building blocks
  - Optional: free text messages
  - Operational in 5 German cities and 8 counties
  - August 2013: > 80,000 subscribers
  - Core technology also used in a weather-alert system with more than 500,000 subscribers

Study: Alert Message Diffusion

- Study conducted in Aurich county (rural coastal area in Northern Germany, close to the North Sea)
- 362 test users
  - Primarily first responders or multipliers (92%)
  - Almost all were registered for SMS alerts
  - 43 % additionally registered for e-mail-alerts
  - 2% were additionally alerted via pagers
  - Test alert was issued at a random point in time (within a time frame) by the regional emergency management authority
  - Immediate user-feedback required after noticing the alert

Study: Alert Message Diffusion

- The test alert

  (E-Mail version)

Aurich county
Advance warning for authorities:
Code RED serious drinking water incident

ZIP code: 26736

valid from: immediately
until: Monday, August 24th, 2009, 22:00 CET
editing date: August 24th, 2009, 14:09 CET

Advance warning code RED serious drinking water incident
Please contact the situation room. (Test alert)

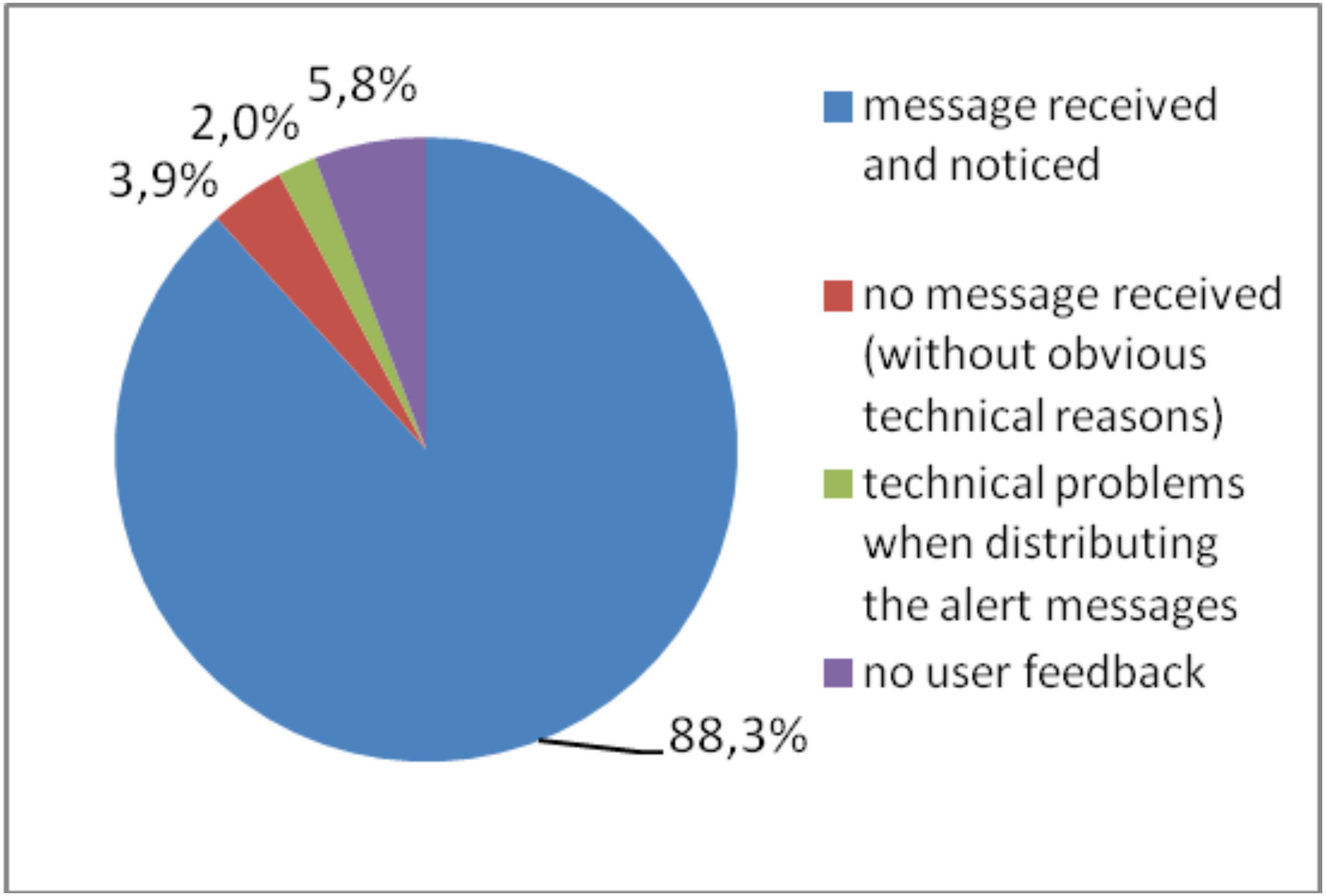
Recommended protective measures:
Don't drink any tap water.

This message was sent by the emergency management agency of Aurich county.

For feedback and comments, please use info@katwarn-aurich.de

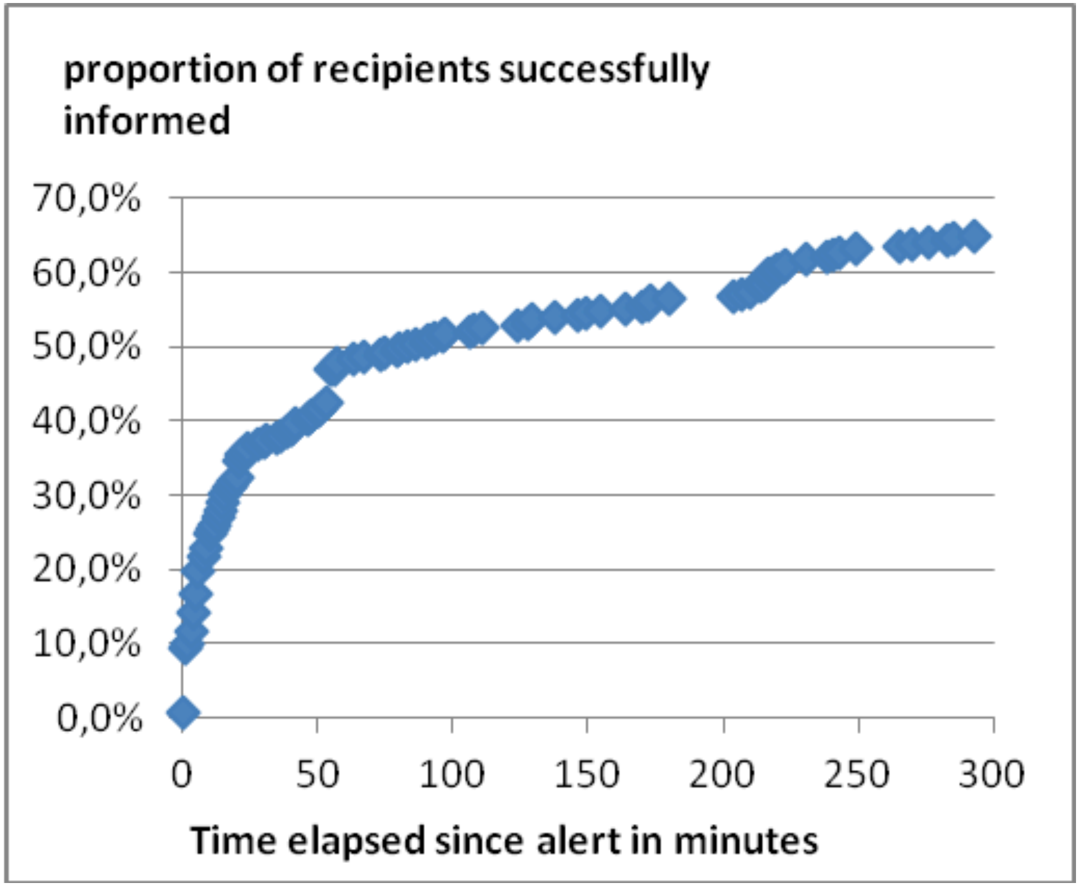
Study: Alert Message Diffusion

- Question one: How many test users did receive the alert?



Study: Alert Message Diffusion

- Question two: When did recipients notice the alert? (alert sent at 14:09 CET)



Study: Alert Message Diffusion

- Observations:
  - Inter-personal effects / multiplication, e.g.:
  - "I confirm that myself and 15 colleagues in the office received the alert"
  - "Me and my wife received the alert"
  - No confirmations received over night (between 23:00 and about 6:00 hours)
  - Short-term alerting efficiency better than via TV and Radio (but slightly inferior to sirens)
  - Caveat: Results only valid for daytime alerts in rural areas!

Modeling the alert message diffusion

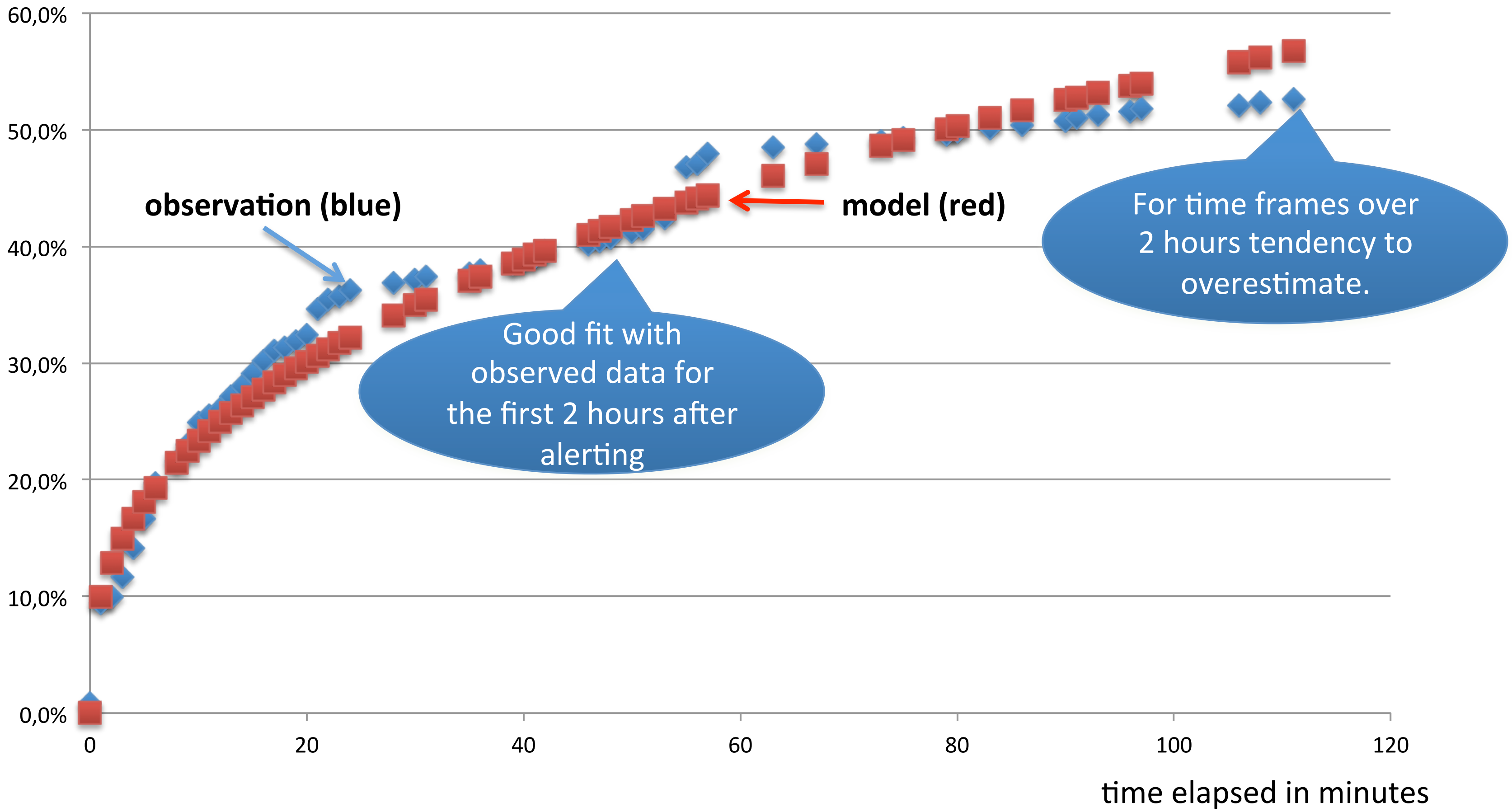
- Direct alerting vs. multiplication effects
- The dissemination function for direct alerting shows a root type functional pattern

Derivation of the dissemination model:

- Derivation of the direct dissemination function from observed data
- Performing of a **least squares optimization on a general root type function** in order to model the time lag between sending the alert and noticing the alert by recipients
- Incorporation of multiplication effects: household size (as surveys indicate that alert recipients will inform family members)
- Incorporation of time: reduced efficiency for nighttime alerts

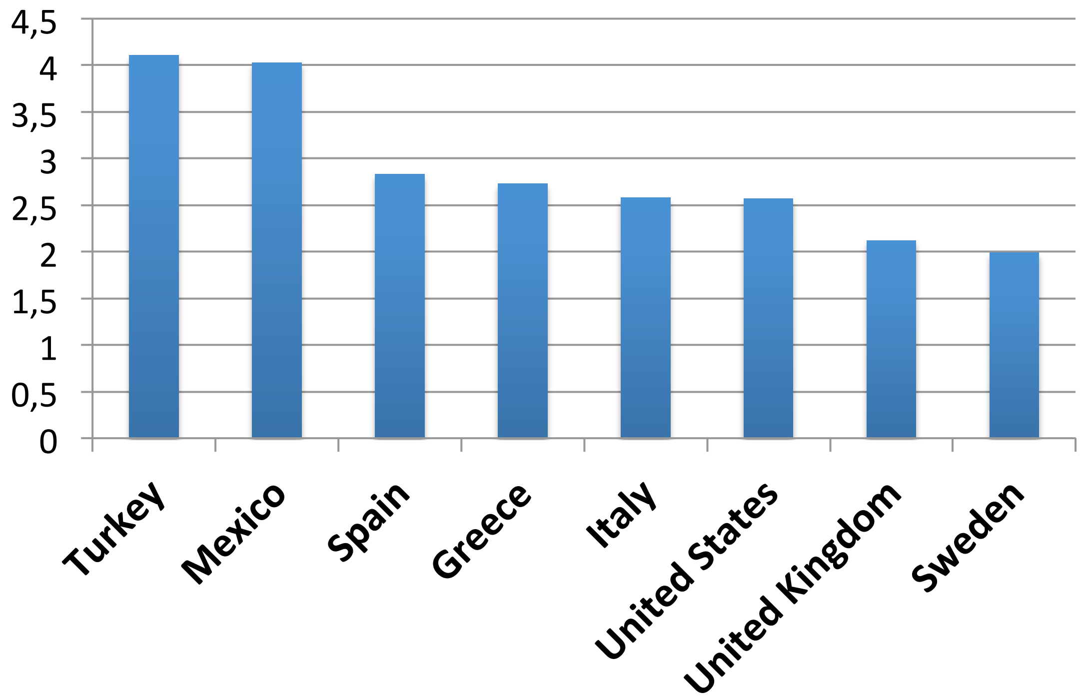
Modeling the alert message diffusion

Functional approximation: share of direct recipients having noticed the alert



Including multiplication effects

- Alert recipients will inform their family and neighbours
- No data available on the the number of neighbours, but data on household sizes are available (regional variations)
- Household sizes in OECD countries (source: OECD, 2009)



The (basic) model

Mathematical description

- **Includes discount factor for nighttime alerts**
- **Includes a factor for opt-in (purchasing of equipment, registration…)**

$$Share_{informed} = 0{,}099630036 * X^{0{,}36942018} * optin * hh * discount * 100\%$$

$Share_{informed}$= share of the population which has directly received and noticed an alert

optin = share of the population typically opted in to the alerting system (if applicable)

x = time elapsed since the alert in minutes (can be used for up to 120 minutes)

hh= average household size in the alerting area

discount = reduced alert perception at nighttime. If alert takes place after 23:00 and before 7:00, set discount := 0,2,
else set discount :=1

Open issues and next steps

- Incorporation of additional alert system types (e.g., sirens or alert systems for specific buildings)
- More precise modeling of multiplication effects required
- Validation of the approximation with additional tests (so far: 3 test alerts conducted)
- Analysis of regional behavioural patterns (big cities, foreign countries…)

Thank you for your attention!

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